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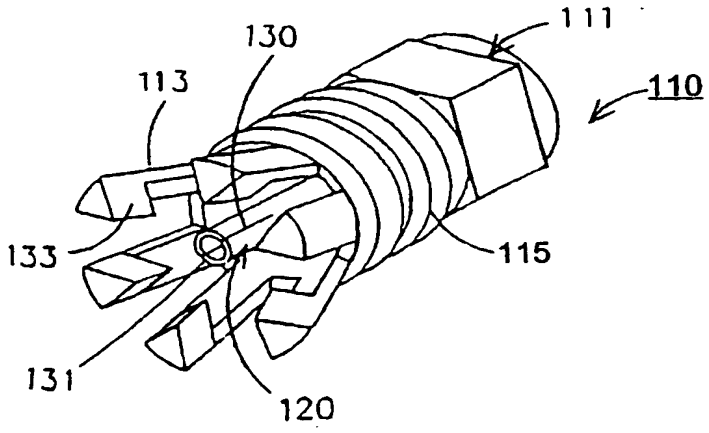
(54) Title: ELECTRICAL CONNECTOR



(57) Abstract: An electrical connector for coupling to an insulated electrical conductor or a coaxial cable having an inner conductor, an inner insulation, conductive sheath and an outer insulation. The connector has a housing having an electrically conductive portion and a bore therein. The connector also has an electrically conductive pin mounted in the housing. The conductive center pin has a hollow portion extending thereinto from the protruding end and an annular sharpened edge on the protruding end. Inserticonan insulating electrical conductor into the housing bore and into engagement with the hollow center pin drives the center pin into the insulation of the electrical conductor and around the electrical conductor's inner conductor. A segmented center pin allows the plurality of segments to expand. One or more conductive arms can be electrically connected to the conductive housing portion and have pointed ends sized for piercing the outer insulation of the insulated electrical conductor.

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DESCRIPTION

ELECTRICAL CONNECTOR

Cross-Reference to Related Applications

This application claims priority to provisional application Serial No. 60/174,446, filed January 5, 2000 and provisional application Serial No. 60/149,117, filed August 16, 1999.

Background of the Invention

The present invention relates to electrical connectors. In specific embodiments, the subject invention pertains to an electrical connector for coupling to an insulated electrical coaxial cable or single conductor cable. In a typical connector, the end of the wire is stripped of insulation and the bare wire is inserted into a connector where it can be soldered or clamped or otherwise attached to the connector.

U.S. Patent No. 5,403,201 discloses electrical connectors of the type including a center pin. The center pins shown in the U.S. Patent No. 5,403,201 are of solid conductive material and engage the center wire of an electrical conductor by piercing the wire if it is multi-strand or engaging it on the side if it is single strand. In the latter case, the electrical connection can be quite good but necessarily only as good as the area of contact between the center pin of the electrical connector and the single strand wire of the electrical conductor and the pressure of engagement at the area of contact.

It is an object of the present invention to improve the center pin type of electrical connector so as to increase the integrity of the electrical connection between the center pin of the connector and the single strand wire of an electrical conductor while at the same time allowing the use of the connector with electrical conductors having multi-strand center wires.

Brief Summary of the Invention

The subject invention pertains to an electrical connector and a method of coupling an electrical connector to an insulated electrical conductor. An electrical connector in accordance with the invention can comprise a housing and an electrically conductive center pin or prong mounted thereto for engaging the center wire of an insulated electrical conductor. The attachment of the center pin or prong to the housing is such that the center pin is electrically insulated from the housing. The housing can incorporate a center bore with the conductive center pin mounted therein such that an end of an insulated electrical conductor can be inserted

into the bore. This center bore can, in certain embodiments, help to guide an insulated electrical conductor into engagement with the center pin. Preferably, the center pin is mounted in the housing such as to protrude toward the open end of the center bore. The center pin can be of solid design or can have one or more hollow portions. In a specific embodiment, the center pin is hollow and open at its exposed end for engaging the center wire of an insulated electrical conductor. Preferably, but not necessarily, the hollow portion of the center pin also incorporates one or more longitudinal slits extending along its side wall. These slits can allow for expansion of the end of the hollow portion of the center pin upon receipt of an electrical conductor which, for example, may be larger in outer diameter than the inner diameter of the hollow end of the center pin. The edge of the receiving end of the hollow portion of the center pin can be beveled and/or sharpened to enhance the ability of the hollow portion of the center pin to squeeze between the center conductor of the insulated electrical conductor and the adjacent insulation layer.

The subject electrical connector can also be utilized with coaxial cable or other insulated electrical conductors which incorporate a center conductor and an outer electrical conductor concentric with such that the outer electrical conductor is separated from the center conductor by a layer of insulation. In a specific embodiment for use with coaxial cable, a center pin makes electrical contact with the center conductor of the coaxial cable and the housing is provided with a means for making electrical contact with the outer electrical conductor. For example, one or more clamping members can be incorporated in the subject electrical connector which can penetrate the outer layer of insulation and make electrical contact with the outer electrical conductor. In an alternative embodiment of the subject invention, the center pin or prong can be substituted for by stripping the insulated electrical conductor such that the center conductor protrudes from an otherwise flush end of the insulated electrical conductor and projects into the connector housing in the place of the center pin.

Brief Description of the Drawings

Figure 1 is an exploded view of an electrical connector and a portion of a coaxial cable in accordance with the present invention.

Figure 2 is an exploded view of the electrical connector of Figure 1 but looking in the opposite direction and having the coaxial cable inserted into the housing cap which has been sectioned for clarity.

Figure 3 is a sectional exploded view of the electrical connector of Figures 1 and 2.

Figure 4 is a sectional view of the electrical connector of Figure 3 having a coaxial cable end attached thereto.

Figure 5 is a perspective view of another embodiment of a coaxial cable connector in accordance with the present invention.

Figure 6 is an unexploded sectional view of the connection of Figure 5.

Figure 7 is a sectional view of the embodiment of Figures 5 and 6 having the cable attached thereto.

Figure 8A illustrates a side view of a conductive pin in accordance with the subject invention, incorporating a hollow portion having a single slit.

Figure 8B shows an end cross-sectional view of the hollow portion of the pin shown in Figure 8A.

Figure 9A illustrates a side view of a conductive pin in accordance with the subject invention, incorporating a hollow portion having two slits.

Figure 9B shows an end cross-sectional view of the hollow portion of the pin shown in Figure 9A.

Figure 10 illustrates a cross-sectional view of an electrical connector in accordance with the subject invention.

Figure 11 is a perspective view of an electrical connector in accordance with the present invention.

Figure 12 is a rear perspective view of the electrical connector of Figure 11.

Figure 13 is a side sectional view of the electrical connector of Figures 11 and 12 having an electrical conductor being inserted thereinto.

Figure 14 is a sectional view of the electrical connector of Figure 13 having an electrical conductor attached thereto.

Figure 15 is a sectional view taken through a second embodiment of an electrical connector of the present invention having an electrical conductor inserted into the connector bore.

Figure 16 is a sectional view of the electrical connector of Figure 15 having an electrical conductor attached thereto.

Figure 17 is a sectional view taken through a third embodiment of an electrical connector of the present invention having an electrical conductor inserted into the connector bore.

Figure 18 is a sectional view taken through an embodiment of an electrical connector of the present invention having an aperture in the insulated base through which a protruding inner conductor of a coaxial cable can pass.

Figure 19 is a sectional view of the electrical connector of Figure 18 having an electrical conductor attached thereto.

Figure 20 shows an end view of an electrical connector in accordance with the subject invention having eight clamping arms which have been manipulated into the clamped position.

Figure 21 shows a specific embodiment of an individual clamping arm broken away from the housing.

Detailed Disclosure of the Invention

Referring to Figures 1-4 of the drawings, an electrical connector **10** in accordance with the subject invention, especially adapted for use with a coaxial cable **11**, is illustrated. The coaxial cable **11** has a center conductor **12**, a surrounding concentric insulation **13**, a concentric conductive wire braid or sheath **14** surrounding the insulation **13**; and an outer insulation **15** covering the conductive sheath **14**. Connector **10** can be adapted to connect a variety of types and sizes of coaxial cables to a variety of plugs, jacks, and connectors, all referred to herein as electrical connectors. Illustrated in Figures 1-4 for purposes of describing a specific embodiment of the subject invention is the male part of a 75 ohm coaxial F-connector. Connection of the coaxial cable **11** to connector **10** can be accomplished without solder and without the need to strip the insulation cover **15** from the cable.

Connector **10** as illustrated in Figures 1-4 includes a connector housing **16** having a cylindrical cable attaching portion **17** which external threads **18** defining a first chamber **20** and a cylindrical housing portion **25** with internal threads **26** defining a second chamber **24**. An electrically conductive pin **19** is mounted to an insulation base **22** within the housing **25** with the base **22** abutting and being secured to a wall portion **25A**. The conductive pin **19** has a tapered prong **21** extending axially into the bore defining the first chamber **20** and also has a cylindrical prong **23** extending axially into the bore defining the second chamber **24**. Electrically conductive arms **27** extend axially from the cable attaching portion **17** of the housing **16**. Each arm has pointed contacts **28** which are also electrically conductive. A plurality of clamping arms **27** are contemplated but a single arm can perform the operation of attaching the coaxial cable **11**. A locking cover **30** is a generally cylindrical conductive member having internal threads **31** adapted to engage the external threads **18** of the connector body portion **17**. The cap **30** has a central bore to receive the coaxial cable and an annular, frustoconically angled wedging portion **32** formed therein. Figure 3 also shows a cup-shaped insulation covering **29** received within the connector housing **16** which provides extra security against contact of the conductive sheath **14** with the connector body **16** metal portions in the event a stray strand of wire from conductive sheath **14** should extend from the cable **11**.

In operation, the tip of the coaxial cable **11** does not have any of the insulation stripped from the conductors **12** or **14** as is normally required to connect a coaxial cable to a connector.

The undisturbed end of the coaxial cable **11** is slidably inserted between the clamping members **27** and into the bore **20.** Sufficient force is provided to push the cable **11** onto the prong **21** and into electrical contact with the center conductor **12.** The electrical conductive contact with the coupling stem portion **19** provides electrical continuity to the probe **23.** The connector **10** can then be attached to an electrical apparatus, such as a television set or the like, or to another coaxial cable.

Once the coaxial cable **11** is pushed into the bore and attached into electrical contact with the prong **21**, the ends of the arms **27** may be clamped to drive the pointed contacts **28** through the outer insulation **15** into the conductive sheath **14.** This may be accomplished manually, by hand or with pliers, in clamping the ends of the arms **27** to force the pointed contacts **28** through the outer insulation **15** of the coaxial cable **11** into the concentric conductive sheath **14** to make an electrical contact therewith.

Alternatively, and in carrying out the same function, the ends of the arms **27** may be clamped by installing the housing cap **30** onto the threads **18** of the housing portion **17** so that wedging portion **32** drives against the ends of the clamps to drive the pointed contacts **28** through the outer insulation **15** and into the conductive sheath **14.** If done manually, the next step is to maintain the cable and the arms **27** in contact by, for example, threading the cap into place or utilizing the heat shrink embodiment, as shown in Figures 5, 6, and 7.

Turning now to Figures 5, 6 and 7, another embodiment of a coaxial cable connector is illustrated in which an electrical connector **35** has an electrically conducting connector body **36.** In Figure 7, the connector **35** has a coaxial cable **11** attached to one end thereof. The other end of the connector **35** has internal threads **37** with a center conductor **39** having a cylindrical conductor portion **38.** In this embodiment, a heat shrinkable insulating sleeve **40** is attached to the conductive connector housing portion **41.** A pointed prong **43** on the stem **39** is disposed in a chamber **42.** The pointed prong **43** is provided for insertion into electrical contact with the center conductor **12** of a coaxial cable **11.** A plurality of clamping arms **44** are connected to the conductive housing **41** and each arm **44** has a pointed prong **45** extending radially inward from the end thereof.

Coaxial cable **11** has electrical insulation **13** around the center conductor **12** which is covered by the concentric conductive sheath **14** which in turn is wrapped in insulation cover **15.** In operation, the coaxial cable **11** end is inserted into an opening **46** in the insulation **40** between the clamping arms **44** and prongs **45.** The prong **43** is driven into or continuously adjacent the center conductor **12** thereby making electrical contact therewith.

The center conductor **12** on coaxial cable is sometimes a single conductor wire and sometimes is formed of multiple strands so that the prong **43** will sometimes be driven into the multiple strand wire and at other times be directed adjacent to the single wire conductor **12**.

Once the cable **11** is inserted and is in conductive contact with the prong, the arms **44** are clamped manually by hand or with a tool so as to cause the pointed prongs **45** to pierce the outer insulation **15** and make conductive contact with the conductive sheath **14**. Alternatively, the heat shrinkable insulation **40** is heated which causes it to shrink tightly onto the housing **41** on onto the cable **11** and the arms **44**. This shrinkage can push the pointed prongs **45** of arms **44** through the outer cover **15** and into electrical contact with the conductor member **14**. In the case of the alternative and to further assure proper contact, the insulation **40** can be pressed by the assembler onto the clamp members **44** to set the prongs **45** through the insulation **15** and into the conductor **14**. The insulating sleeve **40** thus holds the connector **35** to the cable **11** while forming an insulation for the tip of the cable. The arms **44** also lock into the cover **15** to hold the cable in place with the conductive prong **43** making contact with the conductor **12** of the cable **11**. This provides the center conductor **38** with a contact with the cable **11**. The prongs **38** and **43** are mounted to an insulating member **47** which is attached to a wall **36A** of the body **36**.

Referring to Figures 8A, 8B, 9A, and 9B, specific embodiments of a pin which can be utilized with respect to the electrical connectors of the subject invention is shown. For example, either pin shown in Figures 8A and 9A, or variations thereof, can be incorporated with the electrical connectors shown in Figures 1-4 and Figures 5-7. Both Figures 8A and 9A show side views of pins having a hollow portion on one end for receiving an electrical conductor and a solid portion for connecting with and an external apparatus on the other end. Other pin embodiments are possible which, for example, have a solid portion at each end of the pin (as in Figures 1-4) or have a hollow portion at each end of the pin. In addition, the entire pin can be hollow if desired. Preferably, the hollow portion of each pin can have one or more slits. The number, lengths, and widths, of the slits can vary depending on the application. Figure 8A shows a slit which extends about half the length of the hollow portion of the pin, while Figure 9A shows two slits which extend essentially the entire length of the hollow portion of the pin. Figures 8B and 9B show end views of the hollow portions of the pins shown in Figures 8A and 9A, respectively. These slits can allow the hollow portion to expand to just the right size to receive an electrical conductor such that a good electrical contact can be made.

Figure 10 shows an electrical connector in accordance with the subject invention. This connector incorporates a pin **120** which has a hollow portion at each end for engaging a center conductor **124** of a coaxial cable **123**. In another embodiment, pin **120** can be designed, as in

Figures 15 and 16, to accept a center conductor of an insulated wire. In addition, one or both ends of pin **120** could be a solid pin as shown in Figures 1-4, depending on the application. Pin **120** is attached to housing **111** via base **121** which electrically isolates pin **120** from housing **111**. In the embodiment shown in Figure 10, base **121** extends to the edge of the bore where clamping arms **113** protrude from housing **111**. Narrowing the axial length of base **121** in this embodiment can allow a shorter length from the tips **133** of clamping arm **113** to the center of housing **111**, such that propagation losses can be reduced. The reduction in propagation losses can potentially enable the use of the connector for higher frequency signals. Pin **120** is shown as a solid pin through the region of base **121**, but could be hollow through a portion of, or all of, this region. The width of base **121** can be reduced to optimize the performance of the connector. As the width of base **121** is reduced, the width of housing **111** can also be reduced accordingly.

Preferably, a cover or cap can be used to, for example, protect the electrical connections made and/or help maintain clamping arms **113** in position once they have penetrated insulation layer **129** to make electrical contact with conductor **127**. In the embodiment shown in Figure 10, cap **190** is shown as a snap-on cap. Lip **191** of cap **190** is designed to settle into indentation **192** on housing **111**. Other designs for cap **190** can be utilized depending on the application. If desired, o-rings, or other equivalent means, can be incorporated with the use of cap **190** to protect the connection from moisture and other environmental conditions and/or to enhance the performance of the cap. Alternatively, the connector shown in Figure 10 can be utilized without cap **190**.

In a further variation, the arrangement of Figure 10 may be provided with a sleeve **193** which fits over the arms **113A** after they have been clamped into place in the cable **123A** in order to secure the arms to the cable **123A**. Sleeve **193** can be made, for example, of metal, or other appropriate materials. In that arrangement the cap **190A** can be just like the cap **190** or it can be a sleeve or a cap of heat shrink material, that would for example, seal the connection between the cable and the connector. In a manufacturing operation in which the cable is connected to the connector, the cap **190A** could be of molded plastic which would secure the arms to the cable **123A** in which case the use of the ring **193** might not be necessary. In addition, rubber molded coverings can be utilized with the subject connector to cover and hold clamping arms **113** in place.

Referring to Figures 11-14, a specific embodiment of an electrical connector in accordance with the subject invention is illustrated. Electrical connector **110** has a housing **111**. Preferably, as shown in Figures 11-14, housing **111** can have a bore **112** extending thereinto. An insulated electrical conductor can be guided into bore **112** to assist in aligning pin or prong **120** with the center conductor of the insulated electrical conductor. One or more clamping arms

113 can extend from end 114 of housing 111. Clamping arms 113 can be pressed into the outer insulation layer 129 of an insulated electrical conductor 123, the center conductor of which is in contact with center pin 120, to make electrical contact with a second electrical conductor 127 of conductor 123. A cover and/or means for holding clamping arms 113 in place can be incorporated with the subject connector. In the embodiment shown in Figures 11-14, external threads 115 can be located on housing 111 to receive a threaded cap. Other types of caps and cap attachment mechanisms are also possible. Insulated base 116 can attach center prong 120 to the housing such that the center pin is electrically insulated from housing 111.

Once electrical contact is made between center pin 120 and center conductor 124, and optionally between housing 111 and second conductor 127, a variety of designs can be used to enable the connection of connector 110 to other apparatus. For example, a symmetric design can be utilized to connect to a second insulated electrical conductor identical to conductor 123 to form a coupler. A second pin 122 can extend from the housing and be in electrical contact with pin 120 such that pin 122 is in electrical contact with center conductor 124. Other means for allowing an external apparatus to make electrical contact with center conductor 124 can also be used. In the embodiment shown in Figures 11-14, pin 122 allows electrical contact with center conductor 124 while housing 111 allows electrical contact with second conductor 127. Specifically housing 111 can have a second bore 117, which can extend from the opposite side of the base 116. Second bore 117 can have internal threads 118 for attaching the connector to an externally threaded member.

Center pin or prong 120 can extend axially from housing 111 and, as shown in the embodiment shown in Figures 11-14, can extend past the end of bore 112. Alternatively, the end of prong 120 can be within bore 112. Prong 122 can be attached to base 121, insulating prong 122 from the outer conductive portion of housing 111. Prongs 120 and 122 can be one continuously conductive prong, as illustrated in Figures 13 and 14. According electrical contact can be made between the center conductor contacted by prong 120 and a electrical conductor contacting prong 122. Attaching prong 122 may be a solid member, as illustrated, or can be a hollow prong similar to prong 120.

Conductive prong 120 is shown in Figure 13 just prior to engaging with insulated electrical conductor 123 having a conductor 124 surrounded by a concentric insulating layer 125, concentric conductor 127, and outer concentric insulation layer 129, such that a hollow portion of prong 120 will surround and makes electrical contact with center conductor 124 as end 126 of conductor 123 is inserted into bore 112. Prong 120 has a hollow portion beginning at prong end 128 and extending at least as far as conductor 123 may be inserted. Preferably, as shown in Figures 11-14, the hollow portion of prong 120 can have one or more slits extending from end

128 of prong 120 as far up as desired. The slits along the sides of the prong 120 can form one or more prong segments 131. Preferably, prong 120 has two prong segments 131 with sharpened edges and can expand to accommodate different sizes of electrical conductors 124 located inside the insulation. The edge 128 of end 126, namely the end edges of prong segments 131, can be sharpened and/or beveled in either direction, to enhance the ease of insertion between center conductor 124 and insulation layer 125.

At least one, and preferably all arms 113 have an insulation engaging tip 133. This tip can be angled and/or have a sharpened edge, as shown in Figures 11-14, for penetrating and clamping onto the insulated wire 123. Once the insulated conductor 123 is engaged with conductive prong 120, as show in Figure 14, clamping arms 113 can be pushed toward insulated conductor 123 such that tips 133 enter insulation layer 129 of the wire 123, to make electrical contact with conductor 127. This can be done, for example, manually with a person's fingers, with a pair of pliers, or with a special tool for driving tips 133 into the insulation.

The driving tips of the clamping arms can take on a variety of shapes to optimize electrical contact with conductor 127 and the ability to withstand pulling forces on conductor 123 with respect to connector 110. Referring to Figure 21, a single clamping arm 113 broken away from housing 111 is shown. The pointed end 133 of clamping arm 113 can have a variety of shapes, in order to optimize one or more operational characteristics of the subject electrical connector. In the embodiment shown in Figure 21, pointed end 133 is shaped such that as the clamping arms are manipulated to cause the piercing of the outer insulation, the sides 134 of the clamping arms come in contact with the adjacent clamping arms such that contiguous encasement with adjacent clamping arms act to prevent further penetration of the pointed end 133.

Figure 20 shows an end view of an embodiment having eight clamping arms, as shown in Figure 21, which have been clamped into place. Dashed line 200 represents the position of surface 201 of the clamping arms. Preferably, the clamping arms 113 are designed such that surface 201 contacts the surface of the outer insulation of the coaxial cable when the clamping arms are clamped in place. In this embodiment, surface 201 is curved to match and engage the circumference of the outer insulation of the coaxial cable. In this way, the clamping arms 113 contact the outer insulated conductor of the coaxial cable over almost its entire circumferential surface. This large surface area of contact can help to hold the coaxial cable in place. If desired, knurling or other alterations to the surface texture of surface 201 can be made to increase the frictional forces between surface 201 and the coaxial cable. The distance past surface 201 which pointed end 133 protrudes, and therefore will penetrate into the coaxial cable, can be selected such as to optimize one or more performance characteristics of the subject connector. For

example, the amount of protrusion of end **133** can be adjusted such that end **133** contacts but does not penetrate the conductive sheath, just barely penetrates through the conductive sheath, or penetrates through the conductive sheath and into the inner insulation of the coaxial cable.

The curve of the end **133** can also be selected to optimize the performance of the connector. In Figure 20, the curve of end **133** is selected such that the eight ends form a circular pattern of deepest penetration into the conductive sheath of the coaxial cable. This circular pattern can help to reduce reductions in the quality of the electrical signal caused by the electrical connector. The dotted circle in the center of Figure 20 represents the approximate location of the inner conductor of the coaxial cable. The shape of the protruding end **133** can also be adjusted to optimize the degree to which the clamping arms can hold the coaxial cable in the connector, to assist when the cable is pulled with respect to the cable.

Preferably, a cap can be used to hold arms **113** in place once they are driven into the insulation. This cap can be designed to further push tips **133** into the insulation as the cap is positioned. Such a cap can utilize one of a variety of designs. For example, the cap can slide over clamping arms **113** and lock into place on housing **111**, thread onto the housing, fold together and snap, or utilize a heat shrinkable material, to hold itself in position. In a specific embodiment, a closure cap can have insulated conductor **123** passing there through, and fit over the arms **113** to attach to external threads **115**, holding the clamping arms **113** in position with respect to insulated conductor **123**. In a specific embodiment of the subject connector, losses associated from the connector can be reduced by having no bore **112** but, rather having clamping arms **113** extend directly from the portion of housing **111** adjacent base **121** such as to reduce the distance between tips **133** and base **121**. If desired, a ridge can be provided for a snap-on cap to snap onto and hold arms **113** in place.

Turning to Figures 15 and 16, a specific embodiment of an electrical connector **140** for coupling to a center conductor having an outer insulation layer is illustrated. The connector shown in Figures 15 and 16 has a housing **141** having a bore **142** in one end thereof and a bore **143** extending into the other end of the housing **141**. The housing can have external threads **144** on one end thereof and internal threads **145** extending into the bore **143**. A center conductive prong **146** extends axially into the bore **142** and a conductive prong **147** extends axially into the bore **143**. Prongs **146** and **147** are electrically connected and can be one continuous prong supported in the housing **141** by collar **141A**. Prong **146** has a hollow portion **146A** extending from end **150** to receive a center conductor **124**. The hollow portion **146A** of prong **146** is not required to have but may have a single slit **151**, or a plurality of slits in the side thereof to, for example, allow prong **146** to expand as a center conductor enters. Slits **151** can extend the entire length of the hollow portion of prong **146** or any portion thereof. If prong **146** has two or more

slits, the slits can divide the end of the prong **146** into a plurality of segments **152**. In the embodiment shown in Figure 15 and 16, end **150** has been beveled inwardly to allow the segments to more easily drive in between center conductor **124** and insulation layer **125** of the insulated electrical conductor **123.** If desired, end **150** can be beveled in the opposite direction or sharpened on both sides.

The insulated electrical conductor **123** is shown being inserted into bore **142** in Figure 15, and attached to connector **140** in Figure 16. The portion of housing **141** surrounding bore **142** can be sufficiently large in diameter to allow the insulated conductor to be inserted into bore **142** with the hollow portion of prong **152** squeezing between center conductor **124** and insulation layer **125**. Preferably, the open end portion of housing **141** surrounding bore **142** can have one or more slits **153A** extending from the end of housing **141** which can create one of more clamping arms **153**. Preferably, slits **153A** can extend up to the threaded portion **144** and may extend into the threaded portion **144**, if desired. Extending from housing **141**, clamping arms **153** can be dimensioned to allow the insulated conductor sufficient room to enter bore **142** and allow hollow prong **152** to enter between center conductor **124** and insulation layer **125**. After the insulated conductor is correctly positioned within bore **142**, threading of the cap **154** onto the housing **141** can cause the clamping arms **153** to clamp the electrical conductor **123.** This can help to hold the electrical connector and insulated electrical conductor together.

In a preferred embodiment, a cap can be placed over clamping arms **153** to hold them to insulation layer **125**. In the embodiment shown in Figures 15 and 16 closure cap **154** has an open end **155** for passing the electrical conductor **123** therethrough and has internal threads **156** within passageway **157** for attaching to threads **144** of housing **141**. The inside annular surface **158** may be angled for wedging against an angled surface **160** on the extending arms **153** for clamping the arms to the insulation **125**. In an alternative embodiment, cap **154** and housing **141** can be configured for a snap fit, without the need for threads **144** or **156**.

A further embodiment of the invention which incorporates the clamping arms of Figure 10 in the connector of Figure 15 is shown in Figure 17. Specifically, the housing **141** is modified to substitute clamping arms **161**, including engaging tips **162** similar to those shown in Figure 10, for the clamping arms **153** of Figure 15. In this arrangement when the conductor **123** is entered by the hollow prong **146** and fully positioned in the housing **141**, the clamping arms **151** can be mechanically clamped on to the insulating layer **125** of the conductor **123.** In the arrangement illustrated, the engaging tips **162** are selected so as to engage only the insulating layer **125** and not the center conductor **124**, thereby to avoid unwanted electrical conduction from the center conductor **124.** Thereafter the cap **154** is placed over the clamping arms **161** and secured to the housing **141**, holding the conductor **123** in an irremovable position unitary with

the housing **141**. Circumstances might arise where it is desired that the engaging tips **162** pierce the insulating layer **125** and engage the center conductor **124** in order to support electrical conduction with the hollow prong **146**. In that case the housing can provide a conductive path between the clamping arm **161** and the hollow prong **146** and insulating shielding can be provided for preventing the housing from being electrically shorted.

Again, once insulated conductor **123** is engaged with connector **140**, there are a variety of designs which can be used to engage connector **140** with external apparatus to create electrical contact between conductor **124** and the external apparatus. For example, prong **147** can be the same diameter as conductor **124** or can smaller or larger, as desired. Other designs would be readily apparent to a person skilled in the art having the benefit of the subject disclosure.

The method of the present invention involves coupling an electrical connector in accordance with the subject invention to an insulated electrical conductor. Examples of such electrical connectors are shown in Figures 11-14 and Figures 15 and 16. The end of an insulated electrical conductor **123** is guided to the connector housing such that the hollow portion of the center prong squeezes between the center conductor and insulation layer **125**. Accordingly, center conductor **124** makes electrical contact with prong **120** or **122**. With respect to a coaxial cable, clamping arms **113** can then be pushed onto insulation layer **129** to drive the gripping tips **133** into the insulation to make electrical contact with conductor **127**. With respect to an insulated conductor having a single conductor, arms **153** in Figures 15 and 16, can be pushed onto the insulation for holding the electrical conductor to the connector. The connectors shown in Figures 11-16 can, for example, be manually clamped with a person's fingers, clamped with a clamping tool such as pliers, and/or clamped via a closure cap for pressing arms **153** to the insulation. A closure cap **154** can also be used to drive the clamping arms **153** against the insulation, as shown in Figures 15 and 16. Such a closure cap **154** can be designed to fit over tips **133** after tips **133** have been clamped such that cap **154** can push tips **133** a bit further into the insulation and then hold tips **133** in such position.

Referring to Figures 18 and 19, an embodiment of the subject invention is shown which utilizes the inner conductor of a coaxial cable to make electrical contact between the coaxial cable, having the subject electrical connector connected, and other connectors or insulated electrical conductors. The coaxial cable can be stripped such that the end of the cable is flush with the exception of the protruding inner conductor. The coaxial cable can then be inserted into the subject connector such that the protruding inner conductor passes through an aperture in insulating base **121** and into bore **117**. The clamping arms **113** can then be positioned such that electrical contact with conductive sheath **127** is made. If desired, an appropriate means to secure the clamping arms **113** in place can be used to ensure electrical contact with the conductive

sheath **127** is maintained. In addition, if desired, a portion of conductive sheath **127** and outer insulation layer **129** can be stripped, and the aperture in base **121** can be enlarged, such that insulation layer **125** can also pass into the aperture in base **121**. In this embodiment, base **121** can be conducting. For example, base **121** can be an extension of the housing, such that insulation layer **125** functions to insulate the inner conductor of the coaxial cable from the housing.

A hollow segmented center conductive prong in accordance with the subject invention can advantageously provide an improved connection between a connector and an insulated conductor and can accommodate different types and sizes of conductors. In particular, a hollow segmented center prong can enhance the contact made with a solid center conductor. However, the present invention should not be construed as limited to the forms shown which are to be considered illustrative rather than restrictive.

It should be understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and the scope of the appended claims.

Claims

1. An electrical connector for coupling to an electrical conductor of the type having an inner conductor enclosed with an inner insulation and a generally concentric conductive sheath and enclosed in an outer insulation, said electrical connector comprising:

a housing having an electrically conductive portion;

an electrically conductive prong, wherein at least a portion of said prong is hollow for receiving an inner conductor of an electrical conductor; and

at least one conductive clamping arm connected to said electrically conductive portion of said housing and insulated from said electrically conductive prong, said at least one conductive clamping arm each having a pointed end for driving through an outer insulation layer of the electrical conductor and making electrical contact with a conductive sheath of the electrical conductor without contacting the inner conductor.

2. The electrical connector according to claim 1, wherein said hollow portion of said prong comprises at least one slit extending from a first end of said prong.

3. The electrical connector according to claim 2, wherein said at least one slit allows the first end of the prong to expand upon receiving an inner conductor of the electrical conductor.

4. The electrical connector according to claim 2, wherein said hollow portion of said prong comprises a plurality of slits which extend a length of the hollow portion of said prong which receives the inner conductor, wherein said plurality of slits create a plurality of prong segments.

5. The electrical connector according to claim 2, wherein an edge of the first end of said prong is beveled.

6. The electrical connector according to claim 2, wherein an edge of the first end of said prong is sharpened.

7. The electrical connector according to claim 1, wherein said prong is hollow extending from a first end of said prong and hollow extending from a second end of said prong such that the first end of said prong can receive the inner conductor of the electrical conductor and the

second end of said prong can receive an inner conductor of an additional electrical conductor to which the electrical conductor is to be coupled.

8. The electrical connector according to claim 1, wherein said prong is hollow extending from a first end of said prong and solid extending from a second end of said prong such that the first end of said prong can receive the inner conductor of the electrical conductor and the second end can electrically contact an external apparatus to which the electrical conductor is to be coupled.

9. The electrical connector according to claim 1, further comprising:

a means for maintaining said at least one conductive clamping arm in position, wherein once the pointed end of each of said at least one conductive clamp is driven through the outer insulation layer of the electrical conductor making electrical contact with the conductive sheath, said means for maintaining said at least one conductive clamping arm in position is positioned to maintain said at least one conductive clamping arm in position such that said at least one conductive clamping arm maintains electrical contact with the conductive sheath.

10. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position is a snap-on cap.

11. The electrical connector according to claim 10, wherein said snap-on cap comprises a lip which settles into an indentation on said housing.

12. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position is a threadable cap.

13. The electrical connector according to claim 12, wherein said threadable cap comprises internal threads which removably thread onto external threads on said housing.

14. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position comprises an o-ring such that said means for maintaining said at least one conductive clamping arm in position resists moisture.

15. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position comprises a sleeve which fits over said at least one conductive clamping arm.

16. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position comprises molded plastic.

17. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position comprises a rubber molded covering.

18. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position comprises a heat shrink material.

19. The electrical connector according to claim 1, wherein said housing comprises a bore for receiving an end of the electrical conductor.

20. The electrical connector according to claim 19, wherein said housing comprises a second bore for receiving an end of an additional electrical conductor.

21. The electrical connector according to claim 1, wherein said electrical connector comprises a plurality of conductive clamping arms.

22. The electrical connector according to claim 21, wherein upon driving the pointed ends of said plurality of conductive clamping arms through the outer insulation layer and making electrical contact with the conductive sheath of the electrical conductor, a first side of each conductive clamping arm contacts a second side of an adjacent conductive clamping arm such as to prevent further penetration of each conductive clamping arm's pointed end.

23. The electrical connector according to claim 21, wherein a first surface of each conductive clamping arm from which the pointed end extends contacts the outer insulation layer of the electrical conductor such as to assist in holding the electrical conductor in place with respect to said electrical connector.

24. The electrical connector according to claim 23, wherein said first surface is textured such as to increase the frictional forces between said first surface and the outer insulation layer of the electrical conductor.

25. The electrical connector according to claim 23, wherein said first surface is curved to match the curve of the outer insulation layer of the electrical conductor.

26. The electrical connector according to claim 23, wherein the pointed end of each conductive clamping arm extends from said first surface such that when said first surface contacts the outer insulation layer the pointed end contacts but does not penetrate the conductive sheath of the electrical conductor.

27. The electrical connector according to claim 23, wherein the pointed end of each conductive clamping arm extends from said first surface such that when said first surface contacts the outer insulation layer the pointed end just penetrates through the conductive sheath of the electrical conductor.

28. The electrical connector according to claim 22, where the pointed end of each conductive clamping arm is curved such that when the first side of each conductive clamping arm contacts the second side of an adjacent conductive clamping arm, the curved pointed ends of the conductive clamping arms forms a circular pattern.

29. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position slides over said conductive clamping arms and locks into place.

30. The electrical connector according to claim 9, wherein said means for maintaining said at least one conductive clamping arm in position folds together and snaps locked.

31. The electrical connector according to claim 1, further comprising an insulating base which attaches said prong to the housing and insulates said prong from the housing.

32. An electrical connector for coupling to an electrical conductor of the type having an inner conductor enclosed with an inner insulation and a generally concentric conductive sheath and enclosed in an outer insulation, said electrical connector comprising:

a housing having an electrically conductive portion;

at least one conductive clamping arm connected to said electrically conductive portion of said housing and insulated from said electrically conductive prong, said at least one conductive clamping arm each having a pointed end for driving through an outer insulation layer

of the electrical conductor and making electrical contact with a conductive sheath of the electrical conductor without contacting the inner conductor; and

an insulated base attached to the housing, wherein said insulated base comprises an aperture sized to receive the inner conductor of the electrical conductor therethrough,

wherein said electrical connector is designed to receive an end of the electrical conductor stripped such that the end is flush except a protruding portion of the inner conductor, such that the protruding portion of the inner conductor can be passed through the aperture in the insulating base such that the inner conductor then protrudes into a first bore in the housing.

33. The electrical connector according to claim 32, further comprising:

a means for maintaining said at least one conductive clamping arm in position, wherein once the pointed end of each of said at least one conductive clamp is driven through the outer insulation layer of the electrical conductor making electrical contact with the conductive sheath, said means for maintaining said at least one conductive clamping arm in position is positioned to maintain said at least one conductive clamping arm in position such that said at least one conductive clamping arm maintains electrical contact with the conductive sheath.

34. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position is a snap-on cap.

35. The electrical connector according to claim 34, wherein said snap-on cap comprises a lip which settles into an indentation on said housing.

36. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position is a threadable cap.

37. The electrical connector according to claim 36, wherein said threadable cap comprises internal threads which removably thread onto external threads on said housing.

38. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position comprises an o-ring such that said means for maintaining said at least one conductive clamping arm in position resists moisture.

39. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position comprises a sleeve which fits over said at least one conductive clamping arm.

40. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position comprises molded plastic.

41. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position comprises a rubber molded covering.

42. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position comprises a heat shrink material.

43. The electrical connector according to claim 32, wherein said housing comprises a second bore for receiving an end of the electrical conductor.

44. The electrical connector according to claim 32, wherein said electrical connector comprises a plurality of conductive clamping arms.

45. The electrical connector according to claim 44, wherein upon driving the pointed ends of said plurality of conductive clamping arms through the outer insulation layer and making electrical contact with the conductive sheath of the electrical conductor, a first side of each conductive clamping arm contacts a second side of an adjacent conductive clamping arm such as to prevent further penetration of each conductive clamping arm's pointed end.

46. The electrical connector according to claim 44, wherein a first surface of each conductive clamping arm from which the pointed end extends contacts the outer insulation layer of the electrical conductor such as to assist in holding the electrical conductor in place with respect to said electrical connector.

47. The electrical connector according to claim 46, wherein said first surface is textured such as to increase the frictional forces between said first surface and the outer insulation layer of the electrical conductor.

48. The electrical connector according to claim 46, wherein said first surface is curved to match the curve of the outer insulation layer of the electrical conductor.

49. The electrical connector according to claim 46, wherein the pointed end of each conductive clamping arm extends from said first surface such that when said first surface contacts the outer insulation layer the pointed end contacts but does not penetrate the conductive sheath of the electrical conductor.

50. The electrical connector according to claim 46, wherein the pointed end of each conductive clamping arm extends from said first surface such that when said first surface contacts the outer insulation layer the pointed end just penetrates through the conductive sheath of the electrical conductor.

51. The electrical connector according to claim 45, here the pointed end of each conductive clamping arm is curved such that when the first side of each conductive clamping arm contacts the second side of an adjacent conductive clamping arm, the curved pointed ends of the conductive clamping arms forms a circular pattern.

52. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position slides over said Conductive clamping arms and locks into place.

53. The electrical connector according to claim 33, wherein said means for maintaining said at least one conductive clamping arm in position folds together and snaps locked.

54. An electrical connector for coupling to an electrical conductor of the type having an inner conductor enclosed with an inner insulation and a generally concentric conductive sheath and enclosed in an outer insulation, said electrical connector comprising:

a housing having an electrically conductive portion;

at least one conductive clamping arm connected to said electrically conductive portion of said housing and insulated from said electrically conductive prong, said at least one conductive clamping arm each having a pointed end for driving through an outer insulation layer of the electrical conductor and making electrical contact with a conductive sheath of the electrical conductor without contacting the inner conductor

a base attached to the housing, wherein said base comprises an aperture sized to receive the inner conductor enclosed with an inner insulation of the electrical conductor therethrough;

wherein said electrical connector is designed to receive an end of the electrical conductor stripped such that the end is flush except for a protruding portion of the inner conductor, a subportion of which is enclosed with the inner insulation, such that a second subportion protrudes from the inner insulation, such that the second subportion of the inner conductor and the subportion of which is enclosed with the inner insulation can be passed through the aperture in the base such that the subportion of which is enclosed with the inner insulation resides in the aperture and the second subportion of inner conductor then protrudes into a first bore in the housing.

55. The electrical connector according to claim 54, further comprising:

a means for maintaining said at least one conductive clamping arm in position, wherein once the pointed end of each of said at least one conductive clamp is driven through the outer insulation layer of the electrical conductor making electrical contact with the conductive sheath, said means for maintaining said at least one conductive clamping arm in position is positioned to maintain said at least one conductive clamping arm in position such that said at least one conductive clamping arm maintains electrical contact with the conductive sheath.

56. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position is a snap-on cap.

57. The electrical connector according to claim 56, wherein said snap-on cap comprises a lip which settles into an indentation on said housing.

58. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position is a threadable cap.

59. The electrical connector according to claim 58, wherein said threadable cap comprises internal threads which removably thread onto external threads on said housing

60. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position comprises an o-ring such that said means for maintaining said at least one conductive clamping arm in position resists moisture.

61. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position comprises a sleeve which fits over said at least one conductive clamping arm.

62. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position comprises molded plastic.

63. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position comprises a rubber molded covering.

64. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position comprises a heat shrink material.

65. The electrical connector according to claim 54, wherein said housing comprises a second bore for receiving an end of the electrical conductor.

66. The electrical connector according to claim 54, wherein said electrical connector comprises a plurality of conductive clamping arms.

67. The electrical connector according to claim 66, wherein upon driving the pointed ends of said plurality of conductive clamping arms through the outer insulation layer and making electrical contact with the conductive sheath of the electrical conductor, a first side of each conductive clamping arm contacts a second side of an adjacent conductive clamping arm such as to prevent further penetration of each conductive clamping arm's pointed end.

68. The electrical connector according to claim 66, wherein a first surface of each conductive clamping arm from which the pointed end extends contacts the outer insulation layer of the electrical conductor such as to assist in holding the electrical conductor in place with respect to said electrical connector.

69. The electrical connector according to claim 68, wherein said first surface is textured such as to increase the frictional forces between said first surface and the outer insulation layer of the electrical conductor.

70. The electrical connector according to claim 68, wherein said first surface is curved to match the curve of the outer insulation layer of the electrical conductor.

71. The electrical connector according to claim 68, wherein the pointed end of each conductive clamping arm extends from said first surface such that when said first surface contacts the outer insulation layer the pointed end contacts but does not penetrate the conductive sheath of the electrical conductor.

72. The electrical connector according to claim 68, wherein the pointed end of each conductive clamping arm extends from said first surface such that when said first surface contacts the outer insulation layer the pointed end just penetrates through the conductive sheath of the electrical conductor.

73. The electrical connector according to claim 67, where the pointed end of each conductive clamping arm is curved such that when the first side of each conductive clamping arm contacts the second side of an adjacent conductive clamping arm, the curved pointed ends of the conductive clamping arms forms a circular pattern.

74. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position slides over said Conductive clamping arms and locks into place.

75. The electrical connector according to claim 55, wherein said means for maintaining said at least one conductive clamping arm in position folds together and snaps locked.

76. An electrical connector for coupling to an insulated electrical conductor, said electrical connector comprising:

a housing;

an electrically conductive prong, wherein at least a portion of said prong is hollow for receiving an electrical conductor; and

at least one conductive clamping arm connected to said housing, said conductive clamping arm having a pointed end for driving into an insulation layer of an insulated electrical conductor without contacting the electrical conductor,

wherein said prong can drive between the insulation of the insulated electrical conductor and the electrical conductor of the insulated electrical conductor such that electrical contact is

made between said prong and the electrical conductor as the hollow portion of said prong receives the electrical conductor.

77. The electrical connector according to claim 76, wherein the hollow portion of said prong comprises at least one slit extending from an end of the hollow portion of said prong.

78. The electrical connector according to claim 77, wherein the hollow portion of said prong comprises a plurality of slits which extend a length of the hollow portion of said prong which receives the electrical conductor, wherein said plurality of slits create a plurality of prong segments.

79. The electrical connector according to claim 77, wherein an edge of said prong is beveled.

80. The electrical connector according to claim 77, wherein an edge of said prong is sharpened.

81. The electrical connector according to claim 76, wherein said electrical connector comprises a plurality of conductive clamping arms connected to said housing.

82. The electrical connector according to claim 76, further comprising:

a means for maintaining said at least one conductive clamping arm in position, wherein once the pointed end of each of said at least one conductive clamping arm is driven into the insulation layer, said means for maintaining said at least one conductive clamping arm in position is positioned to maintain said at least one conductive clamping arm in position.

83. The electrical connector according to claim 82, wherein said means for maintaining said at least one conductive clamping arm in position is a snap-on cap.

84. The electrical connector according to claim 82, wherein said means for maintaining said at least one conductive clamping arm in position is a threadable cap.

85. An electrical connector for coupling to an insulated electrical conductor, said electrical connector comprising:

a housing; and

an electrically conductive prong, wherein at least a portion of said prong is hollow for receiving an electrical conductor,

wherein said housing comprises a bore having at least one slit extending from an end of the bore,

wherein said prong can drive between an insulation layer of an insulated electrical conductor and the electrical conductor of the insulated electrical conductor such that electrical contact is made between said prong and the electrical conductor as the hollow portion of said prong receives the electrical conductor,

wherein said housing bore is position such that after said prong drives between the insulation layer and the electrical conductor, said bore can be squeezed onto the insulation layer to hold said insulated electrical conductor to said electrical connector.

86. The electrical connector according to claim 85, wherein said housing bore comprises a plurality of slits creating a plurality of bore segments.

87. The electrical connector according to claim 86, further comprising:

a means for clamping said plurality of bore segments onto the insulation layer,

wherein said means for clamping said plurality of bore segments onto the insulation layer holds said insulated electrical conductor to said electrical connector.

88. The electrical connector according to claim 87, wherein said means for clamping said plurality of bore segments onto the insulation layer is a threaded cap.

89. The electrical connector according to claim 87, wherein said means for clamping said plurality of bore segments onto the insulation layer is a snap-on cap.

90. The electrical connector according to claim 88, wherein said threaded cap comprises an angled surface which wedges an angled surface on each of said plurality of bore segments as said threaded cap is threaded.

91. The electrical connector according to claim 85, wherein the hollow portion of said prong comprises at least one slit extending from an end of the hollow portion of said prong.

92. The electrical connector according to claim 91, wherein the hollow portion of said prong comprises a plurality of slits which extend a length of the hollow portion of said prong which receives the electrical conductor, wherein said plurality of slits create a plurality of prong segments.

93. The electrical connector according to claim 91, wherein an edge of said prong is beveled.

94. The electrical connector according to claim 91, wherein an edge of said prong is sharpened.

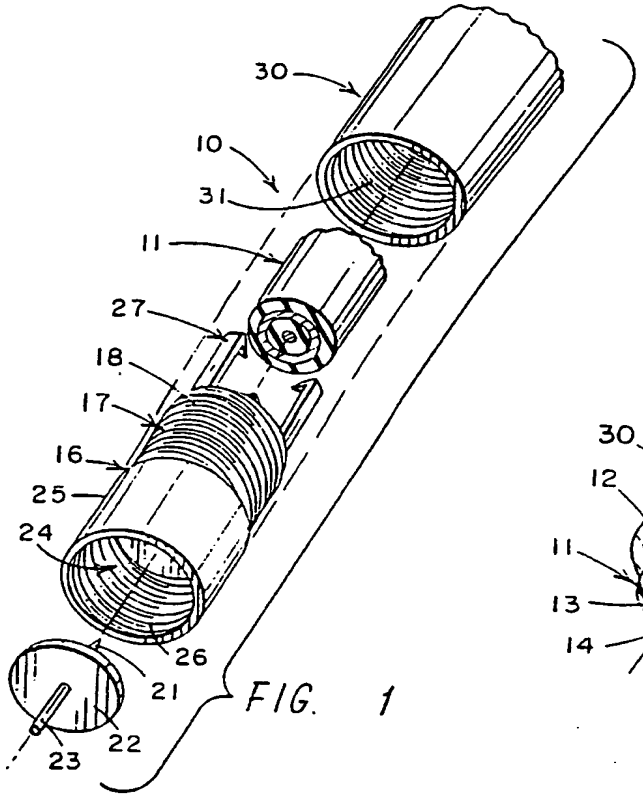


FIG. 1

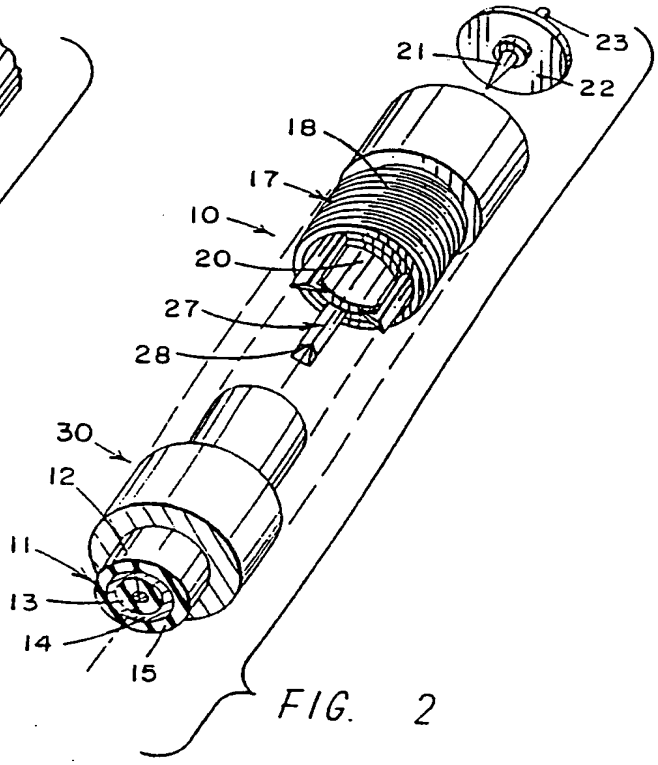


FIG. 2

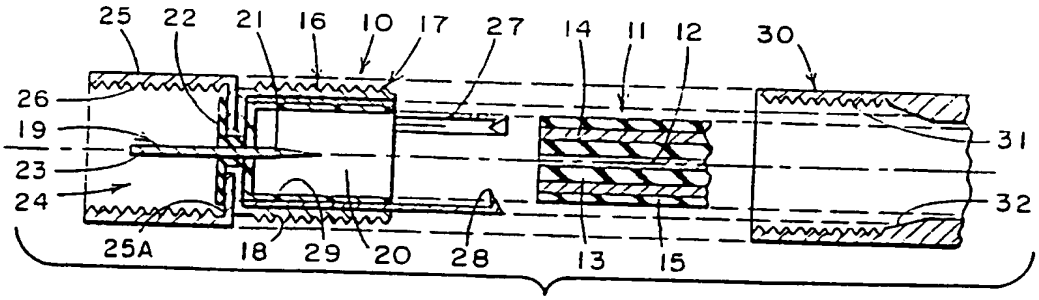


FIG. 3

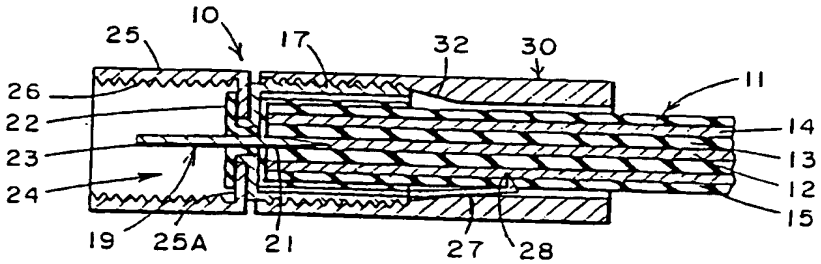


FIG. 4

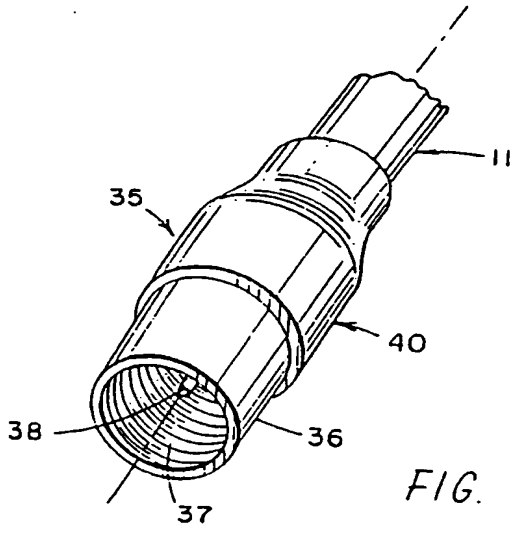


FIG. 5

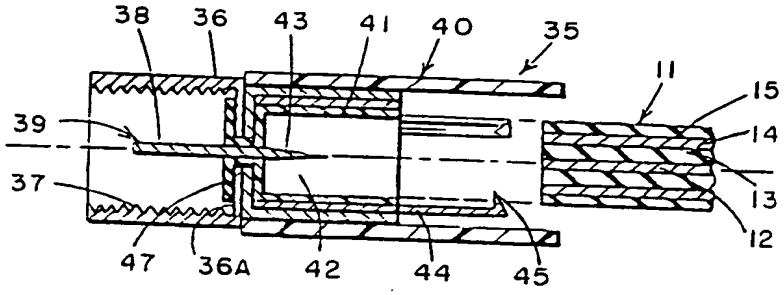


FIG. 6

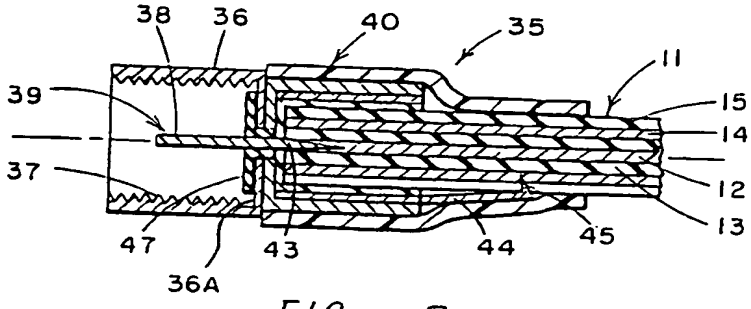


FIG. 7

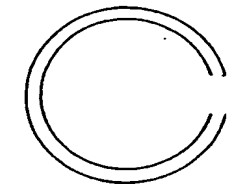


FIG. 8B

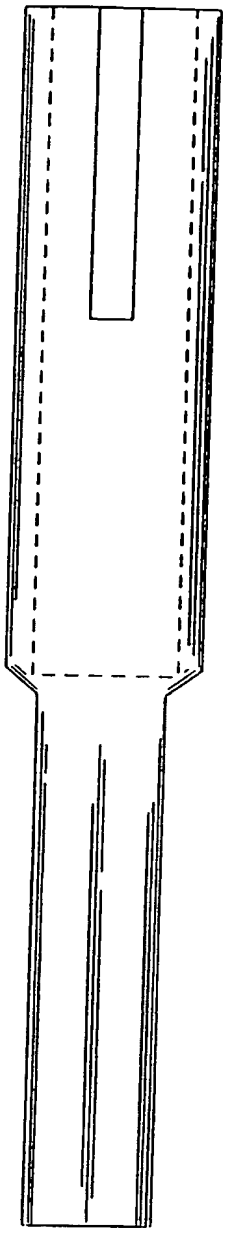


FIG. 8A

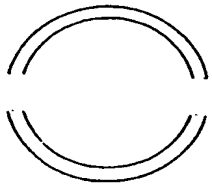


FIG. 9B

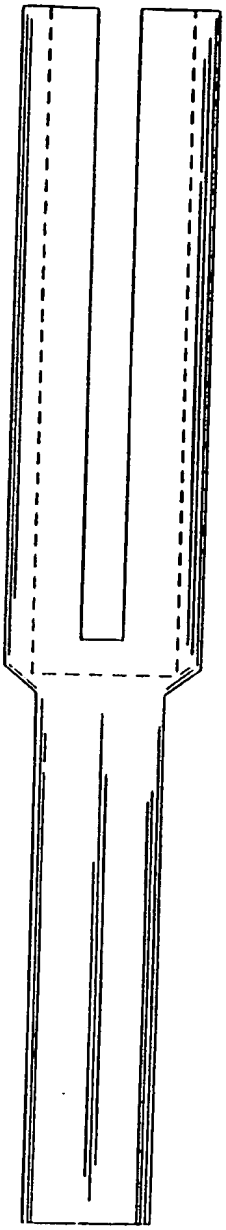
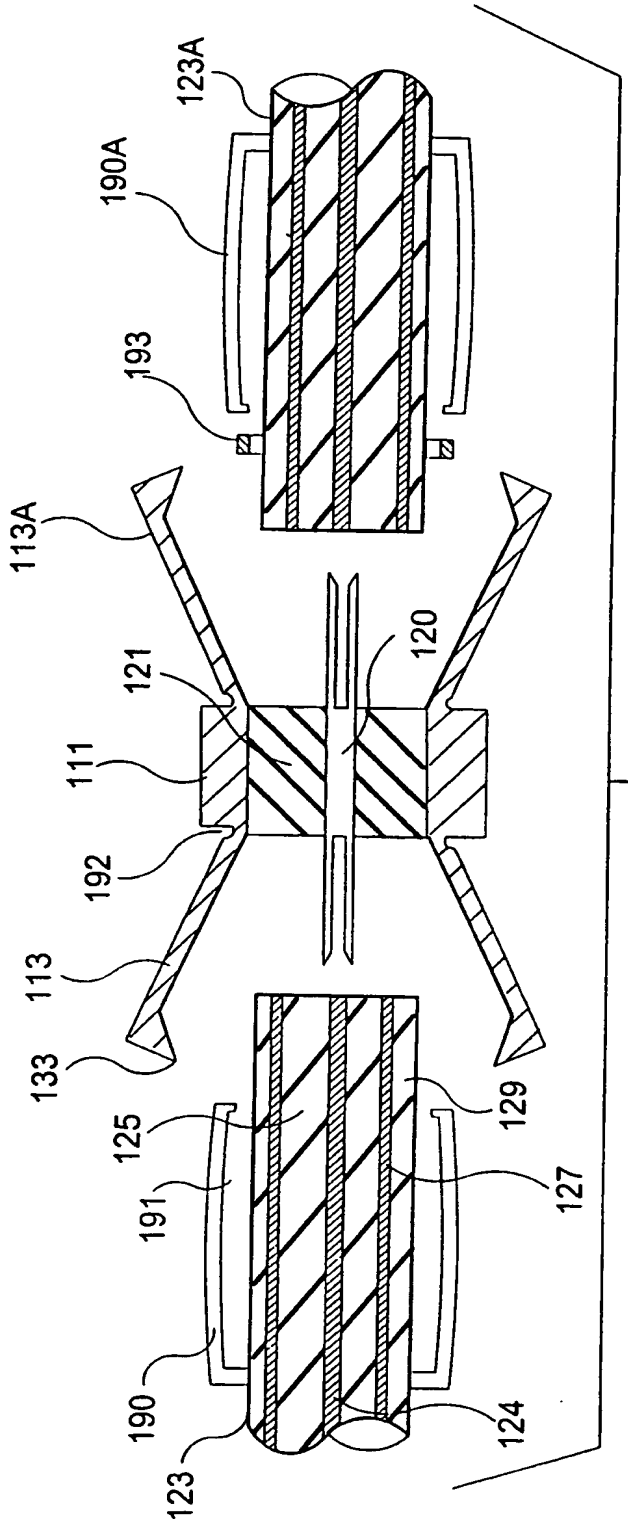


FIG. 9A


123A
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113A
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123

FIG. 10

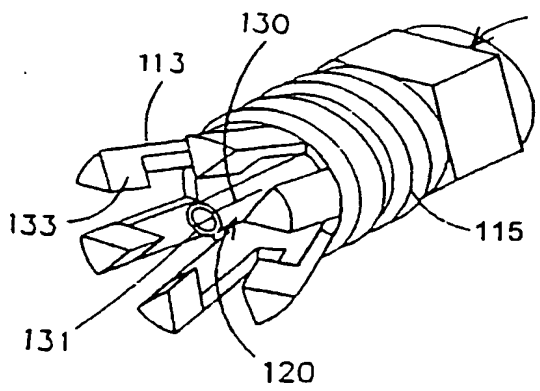


FIG. 11

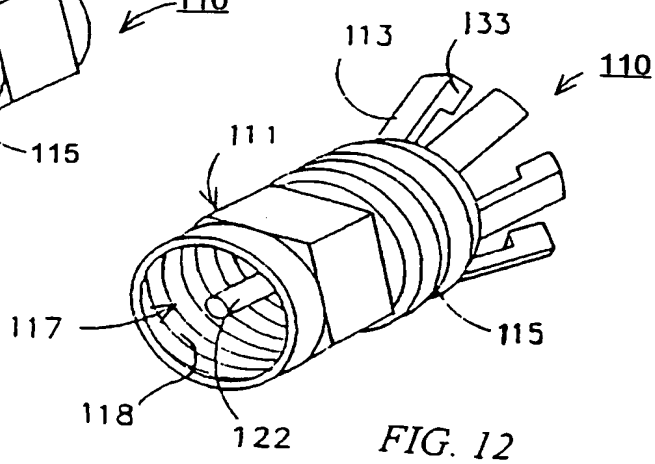


FIG. 12

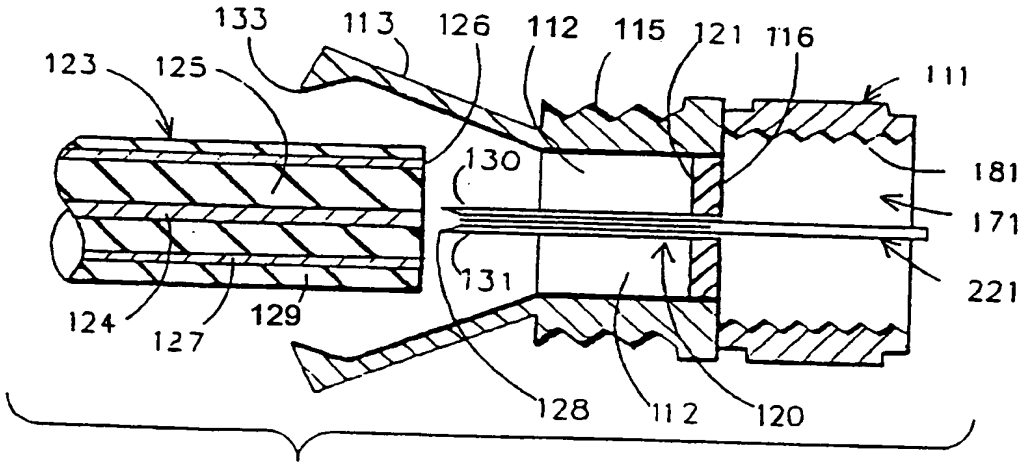


FIG. 13

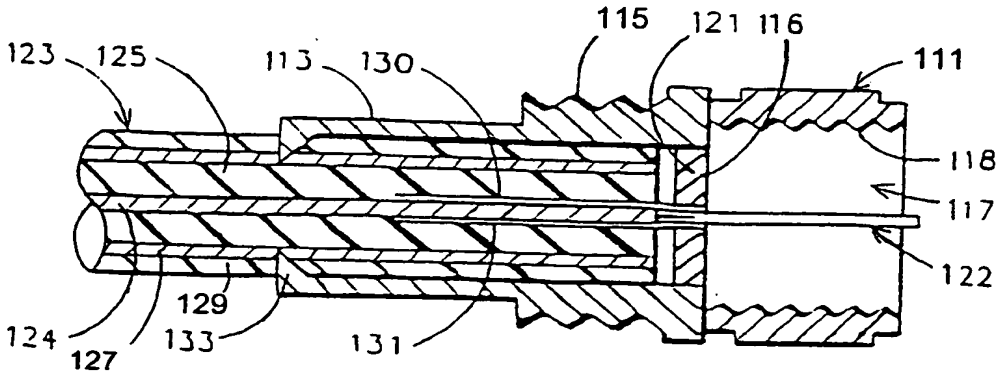
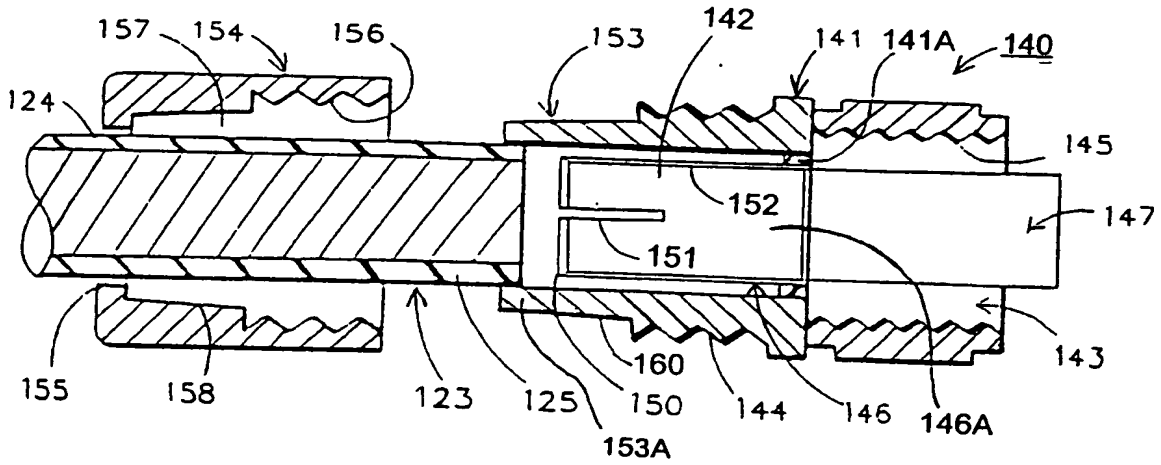


FIG. 14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146A
153A

FIG. 15

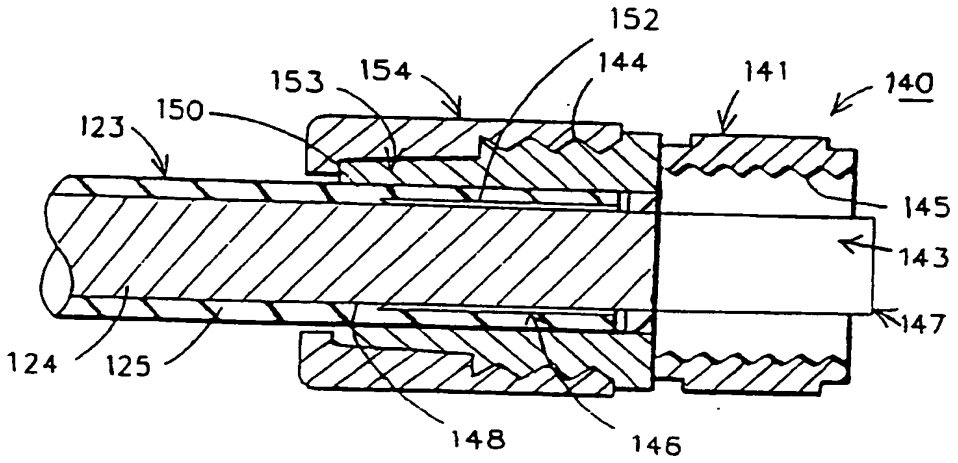
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FIG. 16

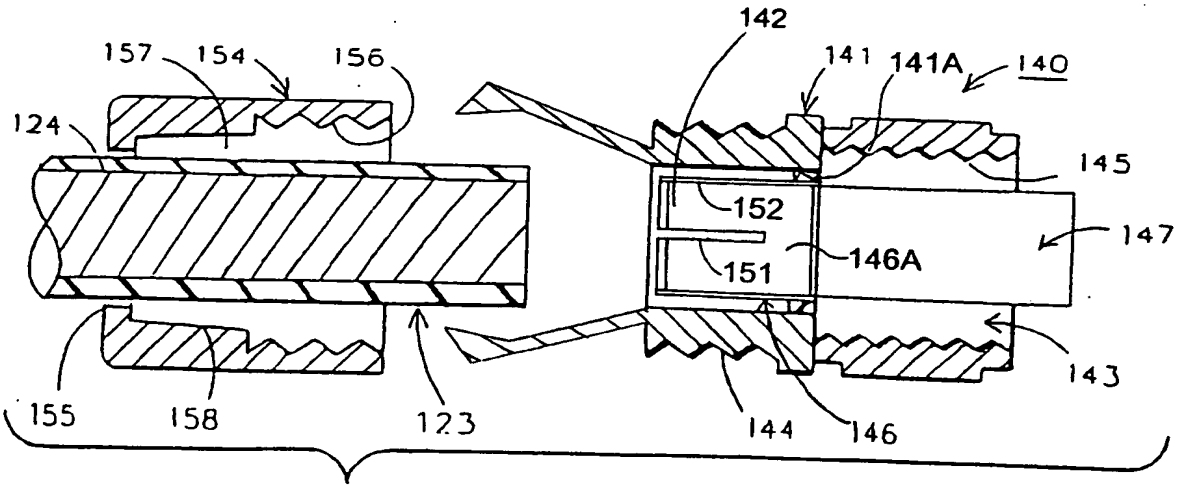

FIG. 17

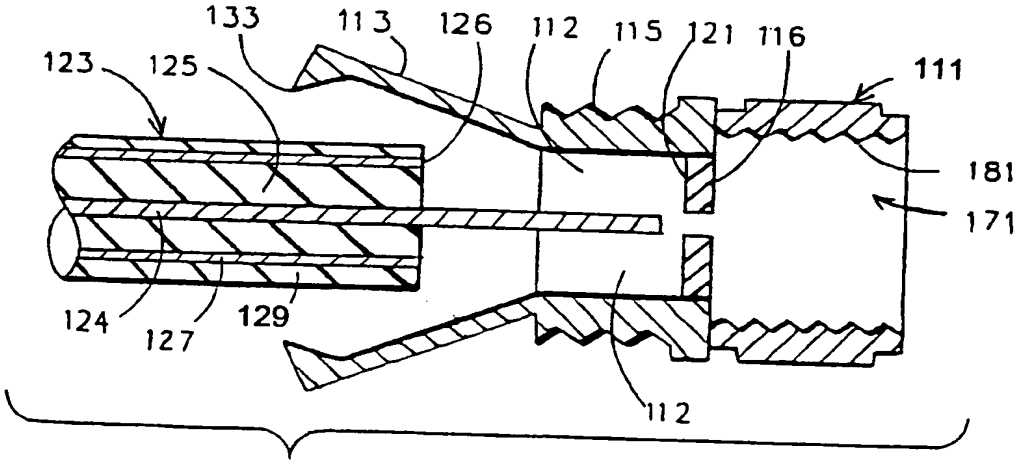

FIG 18

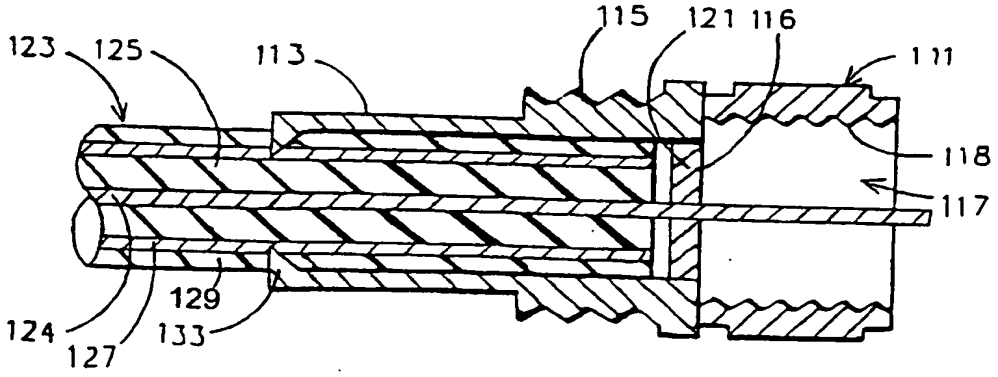

FIG. 19

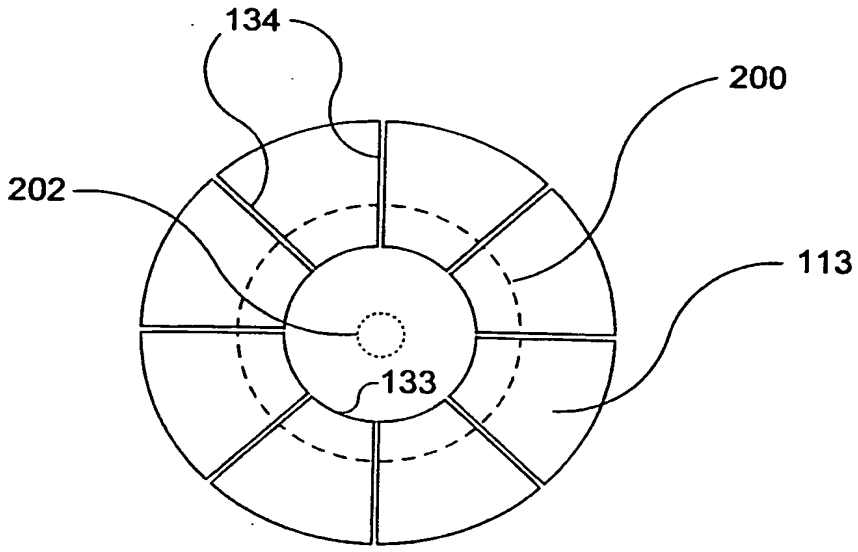

FIG. 20

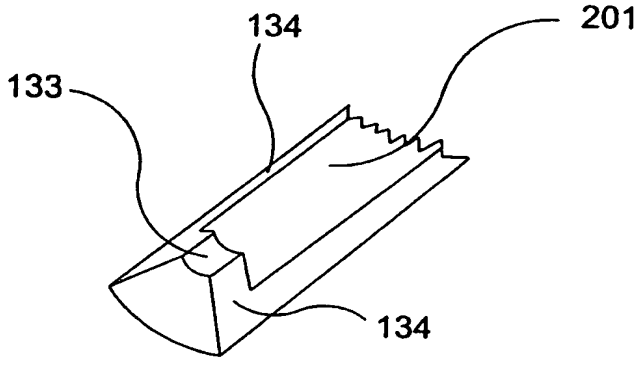

FIG. 21

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/US 00/22426

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01R9/05 H01R4/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 5 775 934 A (MCCARTHY DALE C) 7 July 1998 (1998-07-07) the whole document --- -/--	1,9,15, 18-21, 23,27, 29, 31-33, 39, 42-44, 46,50, 52,76, 81,82,85 54,55, 61, 64-66, 68,72, 74,87

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2000	01/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Salojärvi, K

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INTERNATIONAL SEARCH REPORT

Interr. nal Application No
PCT/US 00/22426

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO 97 34340 A (WHITAKER CORP ;DUQUERROY PATRICK (DE); MEIER PIERRE ANDRE (CH)) 18 September 1997 (1997-09-18) page 4, line 30 -page 8, line 18; figures 1,2A-2D,4,5	1-9,32, 33,54, 76-81, 85,91-94
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A	US 4 739 126 A (GUTTER DAVID H ET AL) 19 April 1988 (1988-04-19) the whole document	1,9,12, 13,32, 33,36, 37,54, 58,59, 76,82, 84,88,90
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